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(54) A method for the manufacture of components made of steel

(57) A method for the manufacture of components made of steel subject to heavy stress, load and/or wear, such as rolling bearing elements,

- starting from a steel having an austenite carbon content at hot forming temperature of about 800 - 1100°C of 0.55-0.85 wt%,
- hot forming of the components above A1 of the steel,
- hardening of the components directly from the hot forming temperature, in air, possibly forced convection aided by addition of water,
- hard machining of the components to their final dimensions,
- surface finishing of the components.

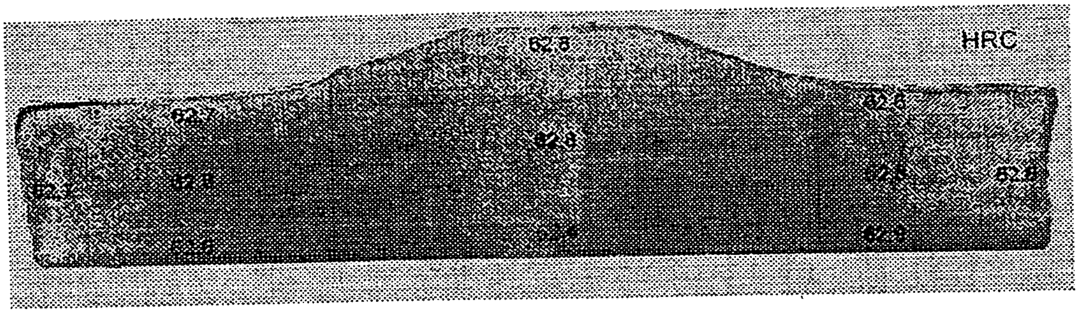

Figure 1

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Description

Technical field

[0001] The invention relates to a method for the manufacture of components made of steel for use under heavy stress, load and/or wear, such as rolling bearing elements.

Background

[0002] Normally, components such as rolling bearing elements are manufactured from a steel with 1 % by weight C. The steel is heated to a temperature of about 1100°C and is given its form in a hot forming step, and is then allowed to cool in air. Next, the steel is soft annealed, then soft machined, thereafter hardened by quenching from 850°C in oil or salt, and then ground and surface finished. After this the elements can be assembled. The most costly part of this manufacturing method is the grinding step. Even if the components have their intended final dimensions and tolerances after the soft machining step, the hardening step will cause distortion of the component, and a large share of the total costs can be referred to the grinding step.

[0003] Further, the components are heated to high temperatures at least twice after the hot forming treatment resulting in a high energy consumption. The process is also time consuming, and because of the quenching step this known process also creates environmental problems and fire hazard.

[0004] SE-C-467 829 discloses a method of producing components from steel with an eutectoidal composition, according to which a blank is formed at a temperature just above the Al temperature of the steel to a shape at least approximately having the final dimensions, whereupon the hot formed component is hardened directly from the hot forming temperature. According to the preferred embodiment no soft annealing step is performed before the heating to the hot forming temperature. The hot forming is a semi-hot forming process, which is performed at 750-800°C, and the component is quenched in oil directly from the hot forming temperature, resulting in a sufficient hardness.

[0005] An important advantage with this process is that the time consuming, costly and complicated soft annealing process can be deleted, but still there is a need for further improvment of this process.

Brief description of the invention

[0006] The object of the invention is to eliminate the above discussed disadvantages, and to provide a method for the manufacture of components made of steel to be used under heavy stress, load and wear, at reduced cost, with lower energy consumption, shorter flow time, more environmentally friendly and more safely, compared to the prior art.

[0007] These and other objects of the invention are obtained with the method according to the invention, as defined in claim 1.

[0008] By using the heat from the hot forming step in the hardening step substantial energy savings are achieved. Hard machining is performed after hardening of the component, and since no hardening takes place after the component has received its final dimensions, little or no grinding is needed, leading to substantial savings in time and cost. A further important advantage is that the conventional quenching step is eliminated, and accordingly environmental and safety risks are eliminated.

[0009] The carbon content in relation to the rest of the alloying components of the steel is to be adjusted such, that the solute carbon concentration in the austenite at the hot forming step is 0.55-0.85 % by weight. With this provision, the components will not crack, and they will be through hardened in the air cooling step.

Brief description of drawing

[0010] The invention will now be described more in detail with the aid of an example and with reference to the accompanying drawing, in which

[0011] Fig. 1 illustrates the hardness distribution in a ring section, true size, produced with the method according to the invention.

Detailed description of the invention

[0012] In the method according to the invention, the steel must be designed to give a proper austenite carbon content at hot forming temperature. A too high content of dissolved carbon will lead to quench cracking.

[0013] Further, the hardenability of the steel must be made such that the ring section through hardens when given a very mild and slow quench, as in air.

[0014] The following example illustrates the invention, but the invention is not limited to the discussed composition of the steel. The skilled man in the art will be able to vary the contents of the different alloying components, depending on the desired properties of the final components, using the information given in the specification.

EXAMPLE

Process

[0015] The aim was to directly through harden rings (9 kg/pcs) after hot rolling. The forging temperature was at the start approximately 1100°C and had decreased to approximately 850°C in the final forming step. The rings were subjected to a slightly forced air-cooling on a conveyer belt. When the rings had reached room temperature they were post-quenched to a temperature of 5°C. After this the rings were tempered at 150° for 1 hr.

[0016] Subsequently, the rings were hard machined and subjected to a surface finishing operation.

Chemical composition of material

[0017] The composition was optimised to obtain equal or improved properties, with a mild quenching from forging temperature, compared to a traditionally processed AISI 52100 steel component (>60 HRC through the section and approximately 15% retained austenite). Since, at forging temperature all the used alloying elements are in solid solution, the following considerations were made:

0.66 wt% C - The carbon content must be low enough to avoid quench cracking and excessive amount of retained austenite but high enough to achieve the desired hardness level.

- 1.45 wt% Si - The silicon content was chosen to be relatively high to increase the hardenability without influencing too much on the Ms-temperature and to suppress the retained austenite decomposition and cementite precipitation. Hence, the hardened and tempered structure will be thermally stable and thus less prone to softening due to thermal exposure.
- 0.28 wt% Mn - a normal level compared to e.g. AISI 52100. Manganese was considered to lower the Ms-temperature too much compared to the gain in hardenability (influence on the pearlite and bainite transformation).
- 1.51 wt% Cr - a normal level compared to e.g. AISI 52100. The chromium will increase the hardenability.
- 1.03 wt% Ni - a nickel addition will significantly increase the hardenability. Furthermore, it will positively influence the toughness of the martensite.
- 0.23 wt% Mo - strongly increases the hardenability, especially pearlite transformation.

Hardness and structure

[0018] The achieved hardness was 62,5 HRC and uniform through the ring section, see Figure 1. The structure was martensite with approximately 15% retained austenite.

Discussion

[0019] Table 1 show the properties of a product made from the new processing route with the new material compared to a traditional martensitic AISI 52100 component.

Table 1

Properties of a component processed with new processing route and optimised steel compared to traditionally martensite hardened AISI 52100 steel components.

	Hardness after tempering (150°C)	**Toughness**	**Structural stability**	**Maximum operating temperature**	**Property of maintaning hardness after long service times.**
New	equal	equal	higher	higher	higher

Claims

1. A method for the manufacture of components made of steel subject to heavy stress, load and/or wear, such as rolling bearing elements, **characterized by**

- starting from a steel having an austenite carbon content at hot forming temperature of about 800 - 1100°C of 0.55-0.85 wt%,
- hot forming of the components above A1 of the steel,
- hardening of the components directly from the hot forming temperature, in air, possibly forced convection aided by addition of water,
- hard machining of the components to their final dimensions,
- surface finishing of the components.

2. A method according to claim 1, utilizing a steel having a composition of >0.55% C, 0-2% Si, 0-2% Mn, 0-20% Cr, 0-5%Ni, 0-3% Mo and additionally 0-1% V and/or Nb.

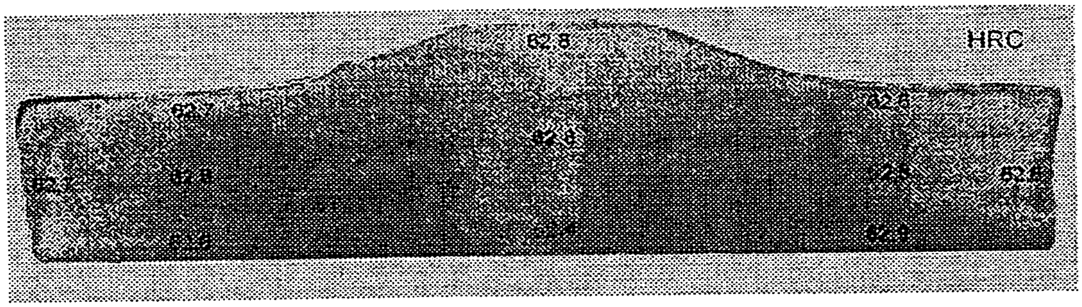

Figure 1

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EUROPEAN SEARCH REPORT

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	24 June 1999	Vlassi, E

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EUROPEAN SEARCH REPORT

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